



PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.: 10/661,195
Filing Date: September 12, 2003
Applicant: Steven G. Goebel
Group Art Unit: 1745
Examiner: Melissa J. Austin
Title: NESTED BIPOLAR PLATE FOR
FUEL CELL AND METHOD
Attorney Docket: 8540Q-000150 (GP-302705)

Director of the United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450

DECLARATION UNDER 37 C.F.R. § 1.131

Sir:

I hereby declare under penalty of perjury as follows:

1. That I am the inventor of the above-identified application.
2. That the invention was conceived by me and at least partially reduced to practice in this country prior to May 30, 2002, the filing date of the United States Pat. Pub. No. 2003/0224239 to Carlstrom.

3. I am the author of the attached Record of Invention attached at Exhibit A.

4. That the invention was conceived and/or reduced to practice prior to May 30, 2002, as evidenced by the Record of Invention attached at Exhibit A in which the invention date that is blacked out on page 2, line 1 was prior to May 30, 2002..

5. That the invention has never been abandoned, suppressed, or concealed.

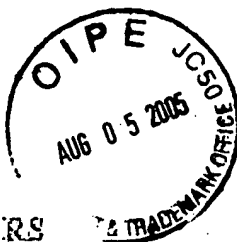
6. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are being made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, and patent issuing thereon, or any patent to which this verified statement is directed.

Dated: 11 Mar 2005

Steven G. Goebel
Steven G. Goebel



GENERAL MOTORS
CORPORATION



File No. GP-302 705

RECORD OF INVENTION

This Record of Invention must be completed with sufficient detail so that your invention can be understood and evaluated by both your engineering management and by a GM Legal Staff patent attorney. Novelty and competitive significance of your invention will be evaluated based on the information you provide.

Invention Title: Nested Stamped Plates for a Compact Fuel Cell

Inventor #1
Name: Steven G. Gosbel Citizen of: USA
First Name Middle Initial Last Name
Social Security No. [REDACTED] GM Employee: ☒ Yes ☐ No ☒ Salary ☐ Hourly ☐ Contract
Home Address: [REDACTED] [REDACTED] [REDACTED]
Street City and State Zip Code
GM Office: Global Alternative Propulsion Center GM Phone No. [REDACTED] [REDACTED]
Contract Number (Area Code) + Number
GM Address: [REDACTED] Mail Code: [REDACTED] FAX Number: [REDACTED]
Contract Number
Non-GM Employer: [REDACTED] Phone No. [REDACTED]
(Area Code) + Number
Non-GM Employer Address: [REDACTED] [REDACTED] [REDACTED]
Street City and State Zip Code

Inventor #2*
Name: [REDACTED] [REDACTED] [REDACTED] Citizen of: [REDACTED]
First Name Middle Initial Last Name
Social Security No. [REDACTED] GM Employee: ☐ Yes ☐ No ☐ Salary ☐ Hourly ☐ Contract
Home Address: [REDACTED] [REDACTED] [REDACTED]
Street City and State Zip Code
GM Office: [REDACTED] GM Phone No. [REDACTED] [REDACTED]
Contract Number (Area Code) + Number
GM Address: [REDACTED] Mail Code: [REDACTED] FAX Number: [REDACTED]
Contract Number
Non-GM Employer: [REDACTED] Phone No. [REDACTED]
(Area Code) + Number
Non-GM Employer Address: [REDACTED] [REDACTED] [REDACTED]
Street City and State Zip Code

* If there are more than two (2) inventors for this invention use the template at the end of this form.

Answer questions 1 - 8, completing all of them to the best of your knowledge.

1. This invention was first thought of on: _____
2. This invention has been or is expected to be disclosed outside GM on: _____
3. This invention has been used or is committed to be used in production on: _____
4. This invention has been offered for sale outside GM on: _____
5. Was this invention made while working on a Government Contract?
☐ Yes ☒ No

If yes, identify the government Contract No.

6. Identify the product or process in which the invention is incorporated: Fuel Cell
7. List all individuals who can provide information about the making of the invention. This list may include individuals who made the first sketch, description, or tests and individuals who are familiar with the facts relating to the making of the invention.

3. Each inventor has a legal duty to disclose all information known that is material to patentability of this invention. Such information includes the relevant prior art, which may be in the form of current or past products, equipment, processes, materials, patents, publications, advertisements, displays, and unpublished developments and proposals—whether originated by you, others in GIM, competitors, suppliers, customers or others. Such information also includes disclosure of this invention outside GIM, sales and offers of products using this invention, use of this invention in production and disputes about who should be considered as an inventor of this invention. To comply with the duty to disclose, list here and attach a copy of all such information, to the extent known.

1

9. Describe the invention in sufficient detail so that its nature, operation and usefulness can be understood.
(Attach drawings, diagrams and further description, when necessary. Additional guidelines are listed below.)

(attached)

Mechanical and Electrical Devices: Include illustrations assigning reference numbers to the main elements and refer to the reference numbers in a description that explains how the main elements are connected or related and how they operate.

Electrical Circuits and Controls: Include circuit diagrams and a functional description.

Computer Software and Manufacturing or Business Processes: Include a flowchart or other step-by-step overview.

Chemical Inventions: Identify all essential materials used, and alternatives therefor, in chemical terms – not trademarks. Identify and quantify all significant variables (e.g. temperature, pressure, concentration, pH etc.) of the process or material specifying operating ranges and also preferred example. Discuss the significance of each variable. Provide a recipe for at least one working example of the invention.

I hereby assign this invention to _____
and authorize General Motors Corporation to file an application on my behalf.

Steven G. Goebel
INVENTOR - SIGNATURE

Steven G. Goebel
(ALSO, PRINT NAME)

DATE

INVENTOR - SIGNATURE

(ALSO, PRINT NAME)

DATE

INVENTOR - SIGNATURE

(ALSO, PRINT NAME)

DATE

This invention was reviewed and understood by me:

Daniel Miller
1st WITNESS - SIGNATURE

Daniel Miller
(ALSO PRINT NAME)

DATE

Michael P. Chetwicht
2nd WITNESS - SIGNATURE

MICHAEL P. CHETWICHT
(ALSO, PRINT NAME)

DATE

10. What benefits will be realized by using this invention?

This invention allows for the construction of a more compact fuel cell by off-setting the anode and cathode flow channels within a bi-polar plate. The repeat distance is reduced by one channel depth. By using stamped plates, channels can be formed between the two stamped plates for coolant flow.

11. What is the state of development of this invention?

This concept could be considered for more compact stamped plate stacks.

12. To the extent known, what alternatives exist for accomplishing substantially the same result as this invention?

The stamped plates which are currently being used by GM have anode and cathode channels aligned within a bi-polar plate (with coolant channels between), so the repeat distance is one channel depth larger. The referenced patent (in question 8) has offset channels, but does not include cooling within the bi-polar plate.

13. Describe the background of the invention. This description may include the state of the prior art and may identify deficiencies in the prior art that are overcome by this invention.

This invention provides a means to increase the power density of a stamped plate fuel cell. The previous stamped plate designs typically followed the channel arrangement of the prior machined or etched plate designs where the anode and cathode channels were aligned (see cross-section in Figure 1). By offsetting the anode and cathode channels which allows the two stamped plates to be nested, the bi-polar plate thickness can be reduced by one channel depth. The coolant channels are formed by the spaces between the two stamped plates. A manifold section within each bi-polar plate can be provided to allow distribution of reactants and coolant among their respective channels.

Claim

1. A fuel cell stamped bi-polar plate where the anode and cathode channels are off-set (so the two stamped plates are "nested") to allow for a more compact bi-polar plate construction where channels are formed between the two stamped plates for coolant flow.

Description

This bi-polar plate would be formed by nesting two stamped plates. Figures 2 to 4 show cross-sections of the active area for a few possible nesting arrangements. Because reactant gases have to diffuse under the lands (the portions of the bi-polar plates supporting the MEA - Membrane Electrode Assembly) to utilize the MEA in this region, it is desirable to keep the land regions (or required diffusion distance) narrow so that the fuel cell performance does not become limited by gas diffusion. However, the minimum size of the features in the plate are limited by the stamping process which would define a minimum channel width. For the configurations shown in Figures 2 and 3, it can be seen that the diffusion distance for the anode and cathode are twice that for the non-nested configuration shown in Figure 1. For the configuration shown in Figure 2, the nested channels are centered, so a precise fit between the two stamped plates is not required. For the configuration shown in Figure 3, the nested channels are off-set to one side to allow a larger coolant flow channel. This would require a good fit between the two stamped plates, or the two stamped plates could be pressed together possibly using the outer halves of the stamping dies to force conformance of the two plates. For the configuration shown in Figure 4, the pitch of the anode channels is twice that of the cathode channels. This allows the diffusion distance for the cathode to be the same as the conventional configuration shown in Figure 1. The diffusion distance for the anode is three times that of the conventional configuration shown in Figure 1. However, this should not be a limiting factor as the diffusivity of hydrogen is more than three times greater than oxygen in nitrogen. Further, for the preferred implementation utilizing pure hydrogen fuel rather than reformat, the hydrogen concentration is not a limiting factor. Further, interdigitated channel patterns can be used to force flow under the lands so that diffusion is not required for gases to get under the lands.

Conventional

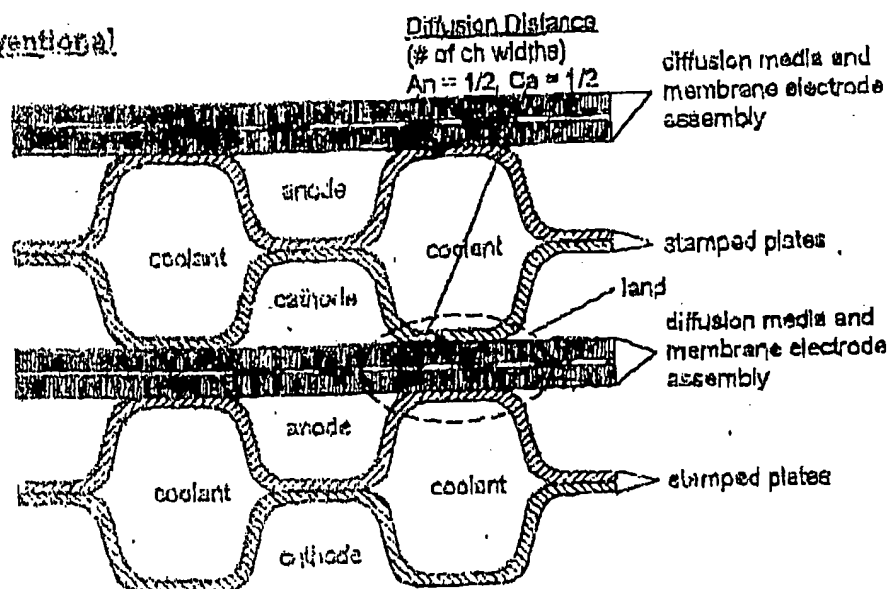


Figure 1 Conventional Stamped Plate Cross-Section

Rev 5/00

File Number

Centered

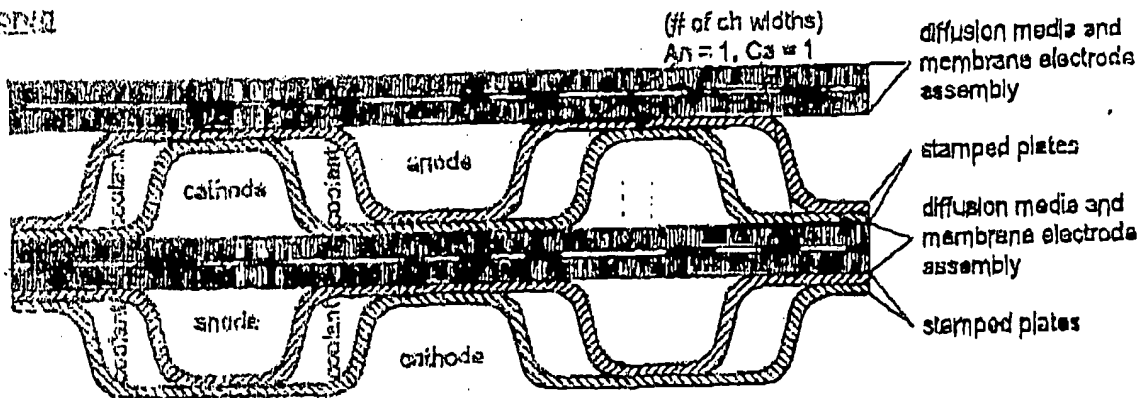


Figure 2 Nested Stamped Plate Cross-Section with Centered Plates

Offset

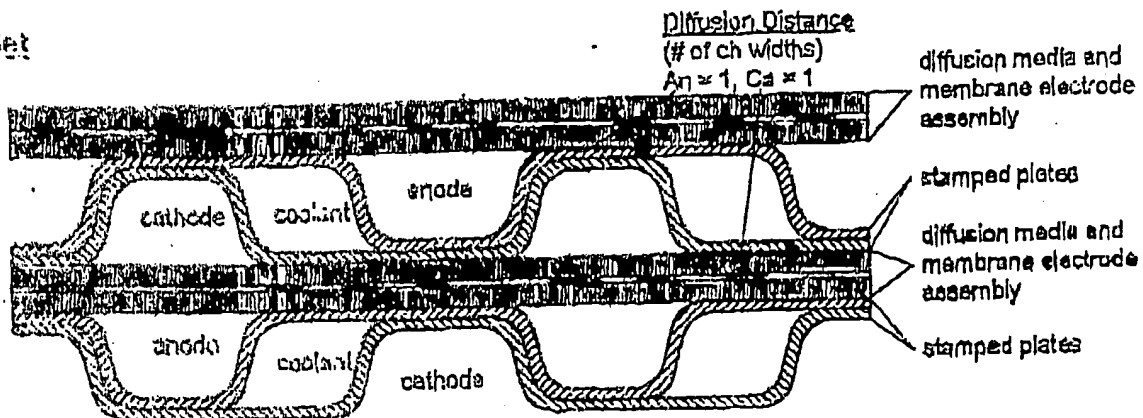


Figure 3 Nested Stamped Plate Cross-Section with Off-Set Plates

Wider Anode Spacing

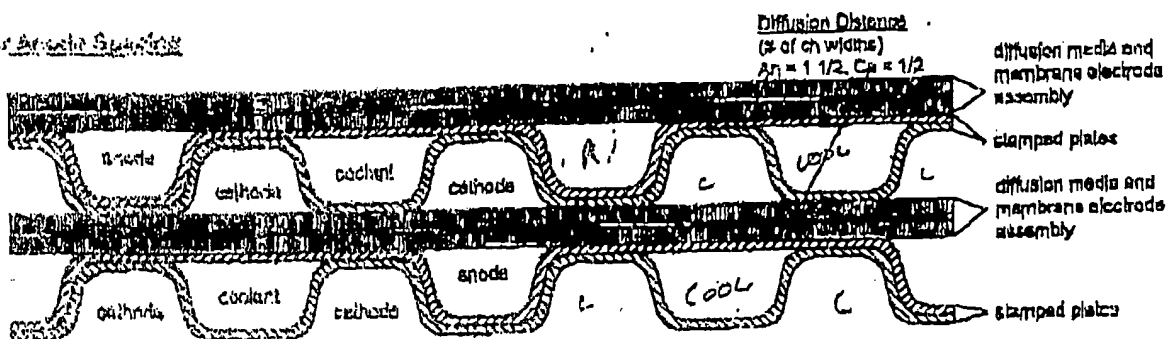


Figure 4 Nested Stamped Plate Cross-Section with Wider Anode Spacing